

**IGI2025**

International  
**Iron Gall  
Ink Meeting  
2025**

*Towards a sustainable preservation*



**POSTERS**

# P1. Metal gall inks in printmaking practices: new insights into the ink composition of prints from the *School of Fontainebleau* and 16<sup>th</sup>-century France

Giovanna Vasco<sup>a, b</sup>, Kilian Laclavetine<sup>b</sup>, Caroline Vrand<sup>c, d</sup>, Eleonora Pellizzi<sup>a</sup>, Vanessa Selbach<sup>c</sup>, Eric Pagliano<sup>b</sup> and Lucy Cooper<sup>a</sup>

<sup>a</sup>Département de la Conservation, Bibliothèque nationale de France (BnF), Quai François Mauriac, 75013, Paris

<sup>b</sup>Centre de recherche et de restauration des musées de France (C2RMF), 14 quai François Mitterrand, 75001 Paris

<sup>c</sup>Département des Estampes et de la photographie, Bibliothèque nationale de France (BnF), 5 Rue Vivienne, 75002, Paris

<sup>d</sup>Département des Arts graphiques, Musée du Louvre, 14 quai François Mitterrand, 75001 Paris

✉ giovanna.vasco@unisalento.it

The School of Fontainebleau, the cultural centrepiece of the French Renaissance, was a highly prolific artistic hub that played a crucial role in the French printmaking practices during the 16th century. King Francis I commissioned an international group of artists from across Europe to decorate his residence at Fontainebleau. The group was initially under the direction of Rosso Fiorentino (1540) and then of Francesco Primaticcio (1542), who had a key role in the Fontainebleau printshop. It is thought that Primaticcio, active in Mantua in Giulio Romano's workshop, imported some of Mantegna's engraved copper plates to France, with consequent production of French copies after Mantegna, and diffusion of printmaking practices. Within a concise period (1542-1547), an incredible number of woodcuts, engravings, and etchings was produced in Fontainebleau. However, considering the frequent lack of signatures and dates, together with stylistic differences, there are many aspects to be still clarified. Furthermore, the influence of the early printmaking practices of the Fontainebleau School on the engraving production of 16th-century Paris should be explored further.

In this study, a set of monochrome prints (brown, red, and black) was selected in order to examine the characteristics of the School of Fontainebleau, its differences with previous Mantegna's production in Italy, and its relationship with the early Parisian printmaking. A multi-analytical approach allowed us to compare Mantegna's engravings, French copies after Mantegna, Fontainebleau etchings, and Parisian prints including both engravings and etchings. Applying Multispectral Imaging (MSI), the designs were compared using Infrared Reflectography (IRR) images, while the large-scale homogeneity of the inks was evaluated observing Infrared False Colour (IRFC) composite images. The microscopic characteristics were observed by using digital microscopes (Hirox in the VIS range, Dino-Lite in the UV-IR ranges). Complementary information was obtained thanks to Raman Spectroscopy, Fiber Optics Reflectance Spectroscopy (FORS), X-Ray Fluorescence (XRF) Spectroscopy, and X-Ray Diffraction (XRD).

Differences, similarities and peculiarities were thus highlighted, better delineating aspects of the Renaissance French printshops and, as far as we know, providing the first scientific evidence of the addition of metal inks for printmaking practices.

## P2. Preliminary investigation of the chemical and morphological effects of nanocellulose treatment on alum-rosin and gelatine sized paper

Samantha Schireson<sup>a</sup>

<sup>a</sup>National Library of Scotland

✉s.schireson@nls.uk

This preliminary study presents the results of a master's dissertation investigating the effects of nanocellulose treatment on alum-rosin sized paper. Despite the established benefits of nanocellulose in paper conservation, research specifically focusing on its interaction with historical sizing agents, particularly gelatine, remains limited. Our experimental framework, inspired by previous successful studies, employed FTIR and SEM-EDX analyses to assess the chemical and morphological impacts of nanocellulose on aged paper samples. Results indicate that the combination of a low concentration gelatine solution followed by nanocellulose treatment leads to notable changes in chemical composition and surface morphology, including a reduction in iron ions and enhanced uniformity of surface coverage. This research demonstrates the efficacy of nanocellulose in improving the structural integrity of historical papers and offers insights into the compatibility of nanocellulose with various sizing agents. By systematically exploring these interactions, this highlights the potential for further investigation into nanocellulose applications in the field.

### References

- L. Gmelch, E. M. L. D'Emilio, T. Geiger, C. Effner, 2024. JPC, 25.1, pp. 6-19.
- L. Völkel, K. Ahn, U. Hähner, W. Gindl-Altmutter, A. Potthast, 2017. Heritage Science
- R. Dreyfuss-Deseigne, 2017. JPC, 18.1, pp. 18-29.

# P3. Spectroscopic analysis for the identification of historic inks on works of art and documents on paper from Slovenian national collections

Klara Retko<sup>a,b</sup>, Lea Legan<sup>a</sup>, Maša Kavčič<sup>a</sup>, Polonca Ropret<sup>a,b</sup> and Jasna Malešič<sup>b,c</sup>

<sup>a</sup> Institute for the Protection of Cultural Heritage of Slovenia, Research institute, Slovenia

<sup>b</sup> University of Ljubljana, Faculty of Chemistry and Chemical Technology, Slovenia

<sup>c</sup> National and University Library, Slovenia

✉ klara.retko@zvks.si

Throughout history, various inks, such as carbon-based, iron gall, and logwood inks, have been used for writing and drawing.<sup>1,2</sup> Iron gall ink was the predominant ink in Europe from the Middle Ages until the early 20th century. This study investigates various inks applied to substrates like Whatman filter paper, machine-made paper, and handmade rag paper using spectroscopic techniques (Raman, infrared (FTIR), X-ray fluorescence (XRF)). To mimic the characteristics of original works, selected samples underwent accelerated degradation in climatic chambers, enabling also the study of cellulose degradation. The results of Size-exclusion chromatography measurements (SEC) revealed that both iron gall and iron-logwood inks contribute to cellulose degradation. Vibrational spectral data from iron gall inks were analysed for variations in paper supports, iron-to-copper/polyphenol ratios, and logwood content. The combined data from both bench-top and portable spectrometers serve as a valuable reference for classifying inks in cultural heritage objects such as manuscripts, drawings, and maps.

Non-invasive techniques (Raman, FTIR, XRF) were used to analyse delicate artifacts from the Slovenian National and University Library and the National Gallery of Slovenia, including 19th and 20th-century manuscripts and drawings. The analysis identified paper components (cellulose, lignin, clay minerals, gelatine) and key materials such as carbon-based and iron gall inks, and in some cases, pigments in coloured areas. These findings enhance the understanding of the composition and preservation of cultural heritage.

## Acknowledgment

The authors would like to thank the Slovenian Research and Innovation Agency (ARIS) for the following grants (projects): Z1-4404, E-RIHS.SI (infrastructure program IO-E012). KR would like to express gratitude to Meta Kojc (NUK) and Tina Buh (NG) for their assistance.

## References

1. J. Kolar, M. Strlič, 2006. *Iron gall inks: on manufacture, characterisation, degradation and stabilisation*. National and University Library of Slovenia.
2. H. Neveel, 2021. *Restaurator. International Journal for the Preservation of Library and Archival Material*, 2021, 42, 169-191.

## P4. Reading strikethrough text: advanced imaging to digitally recover the legibility of redacted historical documents

Lucía Pereira-Pardo<sup>a\*</sup>, Juan Torrejón-Valdelomar<sup>a</sup>, Irene Bielli<sup>b</sup>, Eva María Valero-Benito<sup>c</sup>, Miguel Ángel Martínez-Domínguez<sup>c</sup>, Ana Belén López-Baldomero<sup>c</sup>, Francisco Moronta-Montero<sup>c</sup>, Santiago Sánchez-Cortés<sup>d</sup>, Francisco José Gómez-Fernández<sup>a,d</sup> and Berta García del Real Marco<sup>e</sup>

<sup>a</sup> Instituto de Ciencias del Patrimonio (INCIPIIT), Consejo Superior de Investigaciones Científicas (CSIC)

<sup>b</sup> DISTAV, Università degli Studi di Genova

<sup>c</sup> Departamento de Óptica, Facultad de Ciencias, Universidad de Granada

<sup>d</sup> Instituto de Estructura de la Materia (IEM), Consejo Superior de Investigaciones Científicas (CSIC)

<sup>e</sup> Departamento de Conservación y Digitalización, Archivo Histórico Nacional de España (AHN)

✉ lucia.pereira-pardo@incipit.csic.es

Historical archives hold vast collections of documents written with iron gall ink which have seen their legibility compromised due to multiple factors: fading and corrosion of the ink, water and mould stains, soot deposition, redactions, and so on. Physical treatment of these documents is often beyond the organisations' resources and the capacity of conventional conservation methods. In the framework of the project "Museum of the Invisible", digital recovery of documents legibility by means of advanced image acquisition and processing methods is explored.

Both mock-up samples of inks on paper and parchment and historical documents with readability problems are examined with a range of imaging techniques, namely: multiband imaging (MBI)/technical photography (TP), hyperspectral imaging (HSI)/reflectance imaging spectroscopy (RIS), X ray fluorescence (XRF) imaging and Raman imaging. The images are then further processed to create false colour images, analysed with Principal Component Analysis (PCA) or other methods.

This poster presents, discusses and evaluates the results obtained, with a special focus on the challenge of reading strikethrough text in redacted documents, suggesting the most adequate imaging and processing approaches, in function of the materials present and the type and degree of obscuring of the writing.

### References

- A. Giacometti, et al., 2017. *Digit. Scholarsh. Humanit.*, 32 (1), 101-122.
- M.J. Melo, et al., 2022. *Herit. Sci.*, 10 (1), 145.
- M. Perino, et al. 2024. *Heritage*, 7, 683-696.
- L. Pereira-Pardo et al., 2024. *CULHER*, 68, 342-353.

## P5. Green and sustainable alginate gel for treatment/cleaning of aged iron gall-ink

Matteo Ferretti <sup>(1)</sup>, M. L. Weththimuni <sup>(1)</sup>, C. Milanese <sup>(1)</sup>, D. Sacchi <sup>(1)</sup>, A. Girella <sup>(1,2)</sup> and M. Licchelli <sup>(1,2)</sup>

(1) Department of Chemistry, University of Pavia, Via Taramelli 12, 27100, Pavia, Italy

(2) CISRIC, University of Pavia, Via A. Ferrata 3, 27100, Pavia, Italy

✉ matteo.ferretti02@universitadipavia.it

In this study, we present new gels based on alginate, a natural polymer derived from seaweed, which has been chemically crosslinked using polyamines to enhance its structural and functional properties. This crosslinking method improves the gel's stability, mechanical strength, and overall performance, making it a promising tool for cleaning the aged materials from the conservation and restoration of historical manuscripts and artworks containing iron gall inks.

A multi-analytical approach was employed to characterize the polymer, evaluating its chemical, physical, and mechanical properties. The effectiveness of these gels was tested on a historical Italian ink dating back to the 18th century, which was used by the renowned luthier Antonio Stradivari in his manuscripts and workshop records. To better understand the composition and degradation processes of this ink, a thorough historical reconstruction and scientific characterization were conducted. These analyses were carried out both before and after artificial ageing to simulate the long-term environmental effects on the ink. The simulated ink was compared with the real case.

The primary objective of applying these alginate-based gels is to facilitate the removal of degradation products that form on the surface of iron-gall inks over time. These degradation by products, often linked to oxidation and acidic hydrolysis, can lead to significant damage, including ink fading, paper embrittlement, and structural weakness of historical documents. By carefully controlling the gel's composition and application parameters, it is possible to achieve an efficient and selective cleaning process, preserving the integrity of both the ink and the underlying paper substrate.

Their neutral or slightly alkaline pH helps to mitigate the harmful effects of residual acids present in aged iron gall inks, preventing further hydrolysis and oxidation of the paper fibers. By stabilizing the pH and reducing acidity, the gel contributes to slowing down the degradation process of cellulose, prolonging the lifetime of historical documents.

The use of these innovative gels represents a significant step forward in preventive conservation, ensuring the longevity of valuable historical manuscripts while minimizing the risks associated with traditional cleaning techniques.

### References

E. Guilminot, 2023, *Gels*, 9(3), 191-217.

C. Lee, G. Fiocco, B. Vigani, T. Recca, S. Rossi, M. Licchelli, M. Malagodi, M. L. Weththimuni, F. Volpi, 2024, *J. Cult. Herit.*, 68, 9-16.

G.V. Fichera, P. Dondi, M. Licchelli, L. Lombardi S. Ridolfi, G. Malagodi, 2016, *Appl. Phys. A*, 122, 970-981.

M. Baglioni, G. Poggi, D. Chelassi, P. Baglioni, 2011, *Mol.*, 26(13), 3967-3987.

P. Baglioni, E. Carretti, D. Chelazzi, 2015, *Nat. Nanotechnol.*, 10, 287-290.

## P6. Spectroscopic investigation of iron gall inks degradation in Byzantine manuscripts

Ermioni Vassiou <sup>(1)</sup>, I. Melianos <sup>(2)</sup>, S. Boyatzis <sup>(1)</sup>, A. G. Karydas <sup>(3)</sup>

(1) Department of Conservation of Antiquities and Works of Art, University of West Attica, Greece

(2) Library of the Holy Monastery of Agios Ioannis Theologos Patmos, Patmos Island, Greece

(3) Institute of Nuclear and Particle Physics, NCSR“Demokritos”, Agia Paraskevi, Greece

✉ evassiou@uniwa.gr

Despite progress in the extensive study of substrate degradation by iron gall ink corrosion according to 'Western' Medieval-type of recipes, a full understanding of ink degradation remains incomplete. The present systematic study focuses on iron gall ink degradation, due to their composition, the type of substrate and environmental factors such as Temperature, Relative Humidity and insect infestation.

The study employs two approaches: first, the recreation of iron gall inks using Byzantine recipes, followed by their exposure to artificial ageing conditions (80° C, 65% RH); second, a comparative spectroscopic analysis of manuscripts from the historical Library of the Holy Monastery of Agios Ioannis Theologos on Patmos Island.

The methodological protocol exhibited includes a digital microscope with switchable LED lighting VIS, UV (395 nm) and Near Infrared spectrums (940 nm), alongside Bathophenanthroline indicator strips to characterize first the presence of iron-gall inks and secondly to evaluate on qualitative basis the valence of iron ions ( $Fe^{2+}$ ,  $Fe^{3+}$ ). Further analysis was conducted using MA-XRF imaging to explore spatial elemental correlations and anti-correlations. Additionally, ATR-FTIR spectroscopy provided molecular insights into compounds associated with corrosion mechanisms.

The analysis identified different types of inks, which were well-preserved with minimal adhesion issues on parchment, but exhibited significant corrosion on paper. MA-XRF mapping highlighted the separation of sulfur from iron and its migration to the edges of the letters, while elemental correlations (e.g. iron-potassium, sulfur-calcium) provided information into the formation of colored iron-based complexes in the ink and its corrosion mechanisms. ATR-FTIR detected oxalates, key indicators of iron gall ink degradation, deepening our understanding of manuscript deterioration.

### References

H. de la Codre, M. Radepont, J. P. Echard, O. Belhadj, S. Vaiedelich, V. Rouchon, X-Ray Spectrometry 50(4) (2020), pp. 244-252.

G. Adamia, A. Gorassini, E. Prenesti, M. Crosera, E. Baracchini, A. Giacomello, Microchemical Journal 124 (2016), pp. 96-103.

A. Espina, M. V. Cañamares, Z. Jurašekova, S. Sanchez-Cortes, ACS Omega 7 (2022), pp. 27937–27949.

S. Singh, M. R. Singh, X-Ray Spectrometry 2024 (1) (2023), pp1-14.

## P7. Questioning the origin of lead detected in iron-gall ink manuscripts

Marie Radepont<sup>a</sup>, O. Belhadj<sup>a</sup>, C. Vuillard<sup>a,c</sup>, I. Branco<sup>a,b</sup>, C. Remazeilles<sup>c</sup>, F. Tereygeol<sup>d</sup> and V. Rouchon<sup>a</sup>

<sup>a</sup>Centre de Recherche sur la Conservation, UAR 3224, Muséum national d'Histoire naturelle, CNRS, Ministère de la Culture, Paris, France

<sup>b</sup>Lycée Pierre Gilles de Gennes, ENCPB, Paris, France

<sup>c</sup>Laboratoire des Sciences de l'Ingénieur pour l'Environnement, UMR 7356, CNRS-La Rochelle University, France

<sup>d</sup>Laboratoire Archéomatériaux et Prévision de l'Altération, NIMBE UMR 3685, CNRS-CEA, Saclay, France

✉marie.radepont@mnhn.fr

Many of the iron-gall inks found in ancient manuscripts show, next to iron, presence of manganese, copper, or even zinc. Identification and quantification of these elements by X-ray fluorescence spectroscopy give access to the quality of the vitriol used to prepare them [Vuillard et al. 2024].

In some cases, lead contamination of iron-gall inks is also reported during analyses of ancient manuscripts [Aceto et al. 2017, Del Carmine et al. 1996]. It has been shown that this element cannot be incorporated in the crystalline structure of vitriol, probably because its ionic radius is too large [Vuillard et al. 2024]. Its provenance, still questioned, might be explained by two hypotheses detailed in this work.

The first concerns contamination of the vitriol during its preparation due to use of lead tanks. Indeed, presence of lead-rich sludge inclusions had already been seen during the synthesis of vitriol on the experimental archaeology platform at Melle [Vuillard et al. 2024]. The second hypothesis relies on the diffusion of lead during ink storage in lead bearing metallic inkpots, which is consistent with the affinity of lead with gum arabic [Manawi et al. 2018]. These hypotheses are explored in this work, and the necessary conditions to obtain a lead contamination of the inks, especially regarding the pH of the solutions, will be discussed. Finally, the detection of lead by X-ray spectroscopy on model samples will be verified with the same parameters as the ones used to identify this chemical element in ancient manuscripts.

### References

- M. Aceto, A. Agostino, G. Fenoglio, V. Capra, E. Demaria, P. Cancian, 2017, X-Ray Spectrometry, 46 (4), p. 259-270.  
P. Del Carmine, L. Giuntini, W. Hooper, F. Lucarelli, P.A. Mando, 1996, NIM B, 113, p. 354-358.  
Y. Manawi, G. McKay, N. Ismail, A. Kayvani Fard, V. Kochkodan, M. Ali Atieh, 2018, Chem. Eng. J., 532, p. 828-836.  
C. Vuillard, 2024. Le vitriol au Moyen Age : entre physico-chimie et archéologie expérimentale, PhD thesis, Museum national d'Histoire naturelle, Paris, France.  
C. Vuillard, M. Radepont, F. Tereygeol, C. Remazeilles, V. Rouchon, 2024, JAS Reports, 55, 104460.

## P8. A study on the degradation of iron-gall inks and how to preserve them using green approaches

Maria J. Melo<sup>a</sup>, N. Teixeira<sup>b</sup>, P. Nabais<sup>a</sup>, V. Otero<sup>a</sup>, R. Javier Díaz Hidalgo<sup>c</sup>, M. Ferretti<sup>d</sup>

<sup>a</sup>LAQV-REQUIMTE and DCR, Nova School of Science and Technology, 2829-516 Caparica, Portugal

<sup>b</sup>LAQV-REQUIMTE, DQB, Faculty of Sciences, Universidade do Porto, 4169-007 Porto, Portugal

<sup>c</sup>Departamento de Historia. Facultad de Filosofía y Letras, Universidad de Córdoba, Spain

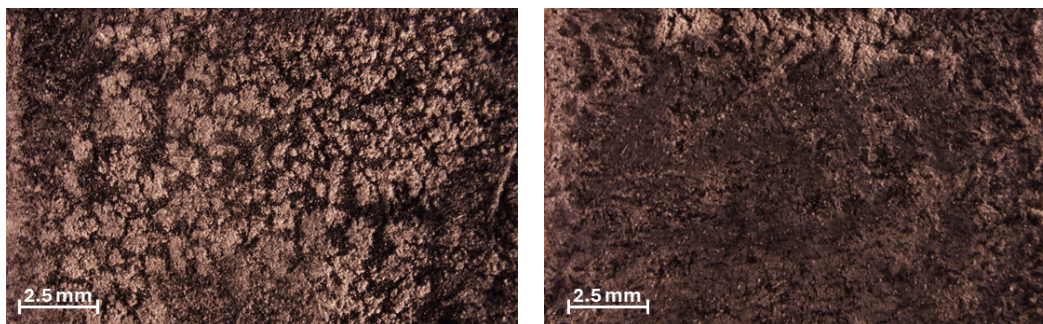
<sup>d</sup>Department of Chemistry, University of Pavia, Via Taramelli 12, 27100 Pavia, Italy

✉mjm@fct.unl.pt

Inks from the 12th to the 17th century were aged, and a multi-analytical approach was used for their identification based on HPLC-DAD-MS, microFTIR, and microRaman. Colorimetry analysis was also performed.

After 6 years of application on filter paper, three inks were selected to be cleaned using a novel green approach based on a chemically crosslinked gel to remove unwanted materials from the ink surface. A Braga ink produced in 2018 was also tested. Two degradation products were identified; iron sulfate was the main degradation product in the Braga ink. For Montpellier, Guadalupe, and QI.8 inks, the main degradation product was a complex of iron with ellagic acid. These compounds were accurately confirmed using microFTIR. Several tests were performed to clean these degradation products with the gels. The Braga ink was cleaned with 10% ethanol in water, which is included in the gel, and the iron sulfate was removed within 15 seconds of application. On the other hand, the complex of iron with ellagic acid demanded longer application times; we used 2 min and repeated the application until the compound was removed.

This study proposes an innovative approach: using a chemically crosslinked gel to remove unwanted materials from the ink surface. The novelty of this research has practical implications for the conservation of historical documents and artworks.



**Figure 1.** The gel was tested on Braga ink for 30 seconds. The main degradation product, iron sulfate, was removed, indicating the gel's cleaning effect.

## P9. Alcohol-based deacidification agents for iron-gall ink documents: a comparative study

Ekaterina Pasnak<sup>a</sup>, Jasna Malešič<sup>b</sup> and Sílvia Sequeira<sup>c</sup>

<sup>a</sup> LAQV-REQUIMTE, Department of Conservation and Restoration, Nova School of Science and Technology, 2829-516 Caparica, Portugal

<sup>b</sup> National and University Library, Turjaška ulica 1, Ljubljana 1000, Slovenia

<sup>c</sup> Laboratório José de Figueiredo, Museus e Monumentos de Portugal, Rua das Janelas Verdes, 1249-018 Lisbon, Portugal

✉ e.pasnak@campus.fct.unl.pt

Iron-gall ink causes paper deterioration primarily through oxidative degradation of cellulose, driven by transition metals like iron and copper. The ink can also catalyse cellulose acid hydrolysis, as its pH may be acidic (2 or lower). Standard treatment for iron-gall ink corrosion involves a two-step process: chelating ferrous ions with calcium or magnesium phytate and neutralizing acidity with calcium bicarbonate. However, both compounds are applied in aqueous solutions, which can pose challenges for water-sensitive iron-gall inks.

To address this issue, we aimed to identify suitable alcohol-based deacidification agents for iron gall-inked documents and compare them to the established aqueous calcium bicarbonate treatment. Whatman No 1 filter paper and handmade gelatine-sized rag paper samples were used. Part of them were left blank, while others were painted with iron-gall ink. The samples were pre-aged at 70 °C and 50% RH for one day and treated with calcium propionate (0.3% and 0.5% w/v in 90% ethanol) [1], calcium hydroxide nanoparticles (0.1%, 0.2% and 0.3% w/v in 2-propanol) [2, 3], calcium carbonate nanoparticles (0.5%, 1%, 2% w/v in 2-propanol) [4], or saturated calcium bicarbonate solution (in water and diluted in ethanol 1:1). Treated samples were subjected to artificial ageing (four days at 70 °C and 50% RH) and analysed using colourimetry, pH measurement (cold extraction) and folding endurance tests.

Preliminary results show that calcium propionate (0.3% and 0.5%) and calcium hydroxide nanoparticles (0.2% and 0.3%) caused significant colour changes to the ink. The most promising results were obtained with calcium carbonate nanoparticles in 2-propanol (0.5% and 1%) and calcium bicarbonate in 50% ethanol, as these treatments minimized colour change while effectively increasing pH to levels below 7.0. A microbiological assay is also underway to assess these compounds' resistance to fungal infestation.

### References

1. Bicchieri, M. et al. 2016. "Alcoholic deacidification and simultaneous deacidification-reduction of paper evaluated after artificial and natural aging." *Journal of cultural heritage* 20: 599-606.
2. Sequeira, S., et al. 2006. "Deacidification of paper using dispersions of Ca(OH)<sub>2</sub> nanoparticles in isopropanol. Study of efficiency." *Journal of cultural heritage* 7 (4): 264-272.
3. Poggi, G. et al. 2011. "Alkaline Earth Hydroxide Nanoparticles for the Inhibition of Metal Gall Ink Corrosion." *Restaurator* 32 (3): 247-273.
4. Malešič, J. et al. 2019. "Nano calcium carbonate versus nano calcium hydroxide in alcohols as a deacidification medium for lignocellulosic paper." *Heritage science* 7 (1): 1-14.

# P10. Reinforcing manuscript pages weakened by iron gall ink with precoated tissue: quick, subtle, and reversible (?) techniques

Christopher Sokolowski

Weissman Preservation Center, Harvard Library  
✉christopher\_sokolowski@harvard.edu

In this presentation, I will describe and illustrate a practical approach to reinforcing fragile manuscript leaves that have deteriorated due to iron gall ink corrosion. I will also address the additional challenges of treating bound manuscripts. Since iron gall ink damage can affect entire leaves (Fig. 1A), overall reinforcement or lining may be a more appropriate treatment option than localized mending.

Drawing on key research from Rouchon et al. (2009) on the detrimental effects of moisture, Pataki (2009) on precoated tissues, and Jacobi et al. (2011) on low-moisture mending, I will investigate the effectiveness of reinforcing weakened manuscript leaves using precoated tissue. This tissue is placed dry on the manuscript and reactivated in situ with dilute Klucel G (hydroxypropylcellulose) in ethanol or a mixture of ethanol and water (Fig. 1B). The main advantage of this method is that it allows precise tissue placement, and adhesive reactivation is easy to control. Moreover, additional weight for drying the lining in place is unnecessary, which is gentler for brittle and cockled manuscript leaves. A case study of a circa 1800 bound manuscript will illustrate the technique in practice.

The focus of this presentation will be on linings made from ultra-lightweight Asian fiber tissues, precoated with wheat starch paste, Klucel G, and gelatin. These precoated tissues will be tested on papers treated with bathophenanthroline reagent and stamped with iron gall ink. The results will be evaluated using imaging techniques to highlight any ink migration or other changes. I will also attempt to remove the linings without altering the state of the test papers to assess whether the risk of reversibility is comparable to the risks of application.

Finally, we will consider whether this current method of reinforcing manuscript leaves represents a true advancement over the lamination and silking techniques used in earlier conservation practices.

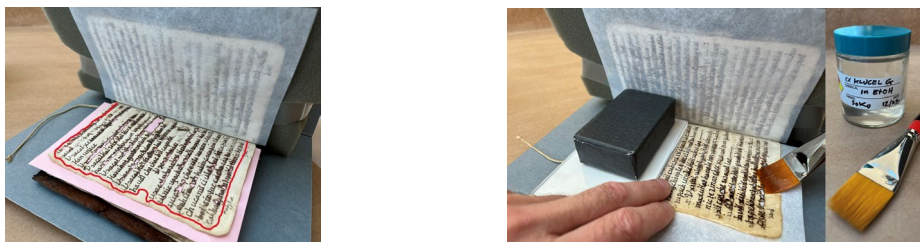


Figure 1. A). Tissue placement zone. B) Activation of tissue in situ.

## References

- V. Rouchon, J. Stordiau-Pallot, B. Durocher, E. Pellizzi, 2009. *Studies in Conservation*, 54(4), 236-254.
- A. Pataki, 2009. *Restaurator*, 30, 51-69.
- E. Jacobi, B. Reissland, C. Phan Tan Luu, B. van Velzen, F. Ligterink, 2011. *J. of Paper Conservation.*, 12, 25-34.

# P11. Iron gall ink migration during aqueous treatments: assessing the sensitivity of the Dutch mending test

Oulfa Belhadj<sup>a</sup>, C. Phan Tan Luu<sup>b</sup>, E. Jacobi<sup>c</sup> and V. Rouchon<sup>a</sup>

<sup>a</sup>Centre de Recherche sur la Conservation, UAR3224, Muséum national d'Histoire naturelle, CNRS, Ministère de la Culture, 36 rue Geoffroy Saint Hilaire 75005 Paris, France

<sup>b</sup>National Archives Prins Willem Alexanderhof 20, The Hague, Netherlands

<sup>c</sup>National Museum of Antiquity, Leiden, Netherlands

✉oulfa.belhadj@mnhn.fr

Iron gall inks are considered less water soluble than watercolours or synthetic dyes, but they still exhibit some affinity for water. This can cause slight bleeding if inappropriate conservation treatments are applied. Although these migrations are subtle and difficult to notice by the naked eye, they are systematically followed by iron migrations, which seriously compromises long-term preservation of the manuscript (Rouchon *et al.* 2009). Conventional solubility testing of the inks proved to be unreliable to assess the migration risk. Therefore, an alternative method was proposed with the Dutch Mending Test (DMT). It is designed to evaluate the safety of the treatment instead of the sensitivity of the inks. The DMT consists of a mock-up made with bathophenanthroline impregnated Whatman paper stamped with iron gall ink. Because the paper is not charged, not sized, this mock-up is highly sensitive to water treatment, and migration of iron is rapidly spotted with pinkish halos forming around the ink line (Jacobi *et al.* 2011). This test, has been largely used in European institutions. Its efficiency and reliability have been evaluated for different types of treatments (Belhadj *et al.* 2014).

The present study aims to evaluate the sensitivity of the DMT with X-ray fluorescence (XRF) spectrometry. XRF is a highly sensitive technique for analysing metals and is frequently used to identify the presence of metals in historical iron gall inks. Experiments were performed with an XRF scanner (M6 Jetstream, Bruker), capable to map the surface of paper with a spatial resolution of 100 µm. Both the DMT test and original manuscripts were exposed to water-based treatments and then scanned. XRF maps revealed the particularly high sensitivity of the DMT test, confirming its value for paper conservators.

## References

- O. Belhadj, C. Phan Tan Luu, E. Jacobi, S. Meslet-Struyve, S. Vez, B. Reissland, V. Rouchon, 2014, *JPC*, 15 (1), 9-15  
E. Jacobi, B. Reissland, C. Phan Tan Luu, B. van Velzen, F. Ligterink, 2011, *JPC*, 12 (2), 25-34  
V. Rouchon, B. Durocher, E. Pellizzi, J. Stordiau-Pallot, 2009, *Stud Cons*, 54, 236-254

## P12. When to treat and not to treat iron gall ink? How to deal with fungal attacks and climate change? What is the alternative?

Valeria Orlandini<sup>a</sup>, David Jacobs<sup>b</sup>, A. Aguirre Vilchis<sup>c</sup>, S. Borrego Alonso<sup>d</sup> and Ramiro Endara<sup>e</sup>

<sup>a</sup>Conservator on Works on Paper in Private Practice, Chevy Chase, MD, USA

<sup>b</sup>Conservator on Works on Paper in Private Practice, London, UK

<sup>c</sup>National Archives of the Congress of Sinaloa, Sinaloa, Mexico

<sup>d</sup>National Archives of Cuba, La Havana, Cuba

<sup>e</sup>Conservatecuador Foundation, Quito, Ecuador

✉valeria.orlandini@gmail.com

For over 1000 years, iron gall ink was the most common ink for writing. Because of its risk of causing ink corrosion then stabilizations have been proposed, e.g. phytate treatment and other methods. The mixture of ethanol to aqueous treatment solutions has been used to mitigate the solubility of water-sensitive media and different water absorption characteristics in the small areas between the blank and inscribed paper. In order to create ethanol-containing iron gall ink treatments the optimal ratios of alcohol with water-based baths have been addressed. The ethanol ratio have been studied even though scarcely conservators are applying the ethanol-modified phytate-bicarbonate solutions. Any treatment will change the material composition of the original thus removing historic information.

A survey was completed by more than two hundred and fifty colleagues from 45 different countries. This ascertained what types of aqueous treatments had been or are currently being carried out by conservators worldwide. One of the main concerns when deciding on a treatment is the potential migration of iron in the form of Iron, Fe (II) ions originating from the ink into the surrounding paper during treatment.

Research has greatly enhanced the conservator's understanding of ink corrosion and provided new ways of addressing the preservation problems, which are repeatedly found in many collections. The effects of different aqueous treatments on metal-tannic ink were considered in the process of finding the right reagents to block ink corrosion mechanisms, further degradation and its effects on paper supports containing fungal attack.

Nevertheless, conservators still struggle in choosing appropriate interventions for mass stabilization. Several material and technical issues and the specific use of the object make these treatments difficult, namely: the complexity of metal-tannic ink, i.e. its variability and lack of predictability, making it inherently difficult to treat; that different condition problems require different solutions, rather than a one-treatment-fits-all approach and finally; that there are still no clear guidelines and methodologies linking the examination for proper identification and history of preparing iron gall inks through the centuries, including industrially made 20th century iron gall ink and prognosis with the various available treatment options.

Identifying such issues and problems that arise in the routine practice are a step toward forming professional networks, exchanging experiences and fostering collaborations. Climatic control is emphasized to be the only reliable means, safe as well for the objects as for humans. This presentation will discuss the impact of research findings on recent treatment choices and procedures.

# P13. Washing of fragile manuscripts written with iron gall ink on Paraprint OL 60

Aušra Čiuladienė

The Wroblewski Library of the Lithuanian Academy of Sciences  
✉ ausra.ciuladiene@mab.lt

The article explores the non-woven capillary material Paraprint OL 60 and its role in preserving water-sensitive documents, particularly in Lithuania where its application remains limited. It underscores the importance of paper as a cultural artefact and the preservation challenges caused by natural aging processes like biodegradation, oxidation, and iron gall ink corrosion.

Capillary washing, a widely used method in paper conservation, involves the removal of soluble acids and stains through water immersion but poses significant risks for sensitive documents. Paraprint OL 60 offers a safer alternative by utilizing capillary action to absorb water, protecting fragile papers, especially those with deteriorating iron gall inks.

This material supports direct washing on its surface, effectively removing acids and contaminants without damaging the ink. Following washing, calcium-phytate stabilization method can be applied to prevent further oxidation and brittleness, which helps to preserve the original text and prolong the paper's life. Alkalization and sizing treatments then add extra protection against degradation and physical wear.

Paraprint OL 60 is particularly convenient, as it allows for calcium-phytate stabilization method directly on the material, minimizing the need to move the document. Overall, Paraprint OL 60 enables effective washing and conservation of iron gall ink documents, incorporating modern paper preservation techniques.

## References

- E. Huhsmann, U. Hähner, 2007. *Restaurator*, 28 (2), 140-151.
- L. Dellapiana, 2016. *News in Conservation*, 56, 16-18.
- H. Sckalkx, P. Iedema, B. Reissland, B. Van Velzen, 2011. *Journal of Paper Conservation*, 12, 11-20.

# P14. Pre-digitisation evaluation and conservation of iron gall ink containing minutes' collection of Riga City Council (1603-1890)

Inta Kirilovica, E. Sondors and I. Cesberga

Latvian National Archives, Department of Preventive Preservation of Documents, Bezdēligu Street 1A, Riga, LV-1048, Latvia  
✉ [inta.kirilovica@arhivi.gov.lv](mailto:inta.kirilovica@arhivi.gov.lv)

The Minutes (or public protocols) of the Riga City Council are vital historical records, documenting discussions and decisions at City Council meetings. These minutes provide a detailed account of Riga's history, its inhabitants, significant events, and daily life. The collection consists of 386 volumes dated from 1603 to 1890. One or two bindings were prepared for each year. Initially bound in parchment, later volumes used leather or half-leather bindings. The minutes were handwritten in German.

In 2021, the Latvian National Commission for UNESCO included the Riga City Council Minutes, held by the Latvian State Historical Archive, in the Latvian National Register of the UNESCO Memory of the World Programme. Digitisation of these minutes was completed between 2022 and 2023.

Before digitisation, the Department of Preventive Preservation of Documents at the Latvian National Archives assessed the bindings' condition. Many exhibited significant iron gall ink corrosion caused by free iron ( $\text{Fe}^{2+}$ ) ions, confirmed through bathophenanthroline indicator paper tests. The ink damage was especially severe in thickly inked areas, such as margin lines and initials, causing browning, visibility of text on reverse side, cracks, tears across the page and loss of paper substance. Although storage conditions had protected the volumes from moisture and mould, the corrosive nature of iron gall ink caused notable damage, affecting text readability in some areas.

To address these issues, conservators reinforced damaged sheets with pre-prepared Japanese paper strips made from Tengujo 5 g/m<sup>2</sup> paper coated with 3 % gelatine glue. The strips were minimally moistened to avoid further ink corrosion. This method effectively replaced traditional conservation techniques, reinforcing damaged parts, and preventing further deterioration.

A severely damaged volume (LNA\_LVVA\_F749\_6\_25) required additional care. Its first signature was partially detached, and the pages showed significant ink corrosion, cracks, tears, and loss of paper substance. Conservators separated the signature, rinsed the pages, stabilized the ink with a calcium phytate solution and deacidified the paper with calcium bicarbonate solution. The pages were then strengthened with 3 % gelatine glue and reinforced using Japanese paper and wheat starch glue.

Overall, 10 % of the bindings required major restoration, while 30 % underwent minor conservation. Approximately 24 % of the volumes had old repairs, and in 10 % of cases, inappropriate materials like linen thread and leather-cloth were used in past restorations. For cover conservation, thick Japanese paper and wheat starch glue was applied. Small leather tears on spines were repaired and partially detached pieces of leather were lined.

To ensure long-term preservation, stable storage conditions are essential, that must align with collection being kept at its original, historical space.

# P15. Local consolidation on a Coptic manuscript in uneven condition

Eve Menei

Independent conservator in Paris

①eve.menei@papyrusetpapierconservation.com

In 2019 I began the conservation of the unbound pages of a Coptic codex in the Louvre Museum (Inv. E 10295b). The pages are made of large sheets of papyrus with two columns written in a beautiful Coptic uncial script. On close examination there are strong differences in the condition of the papyrus and the ink, depending on the area.

In the top centre of each page an area seems to have suffered some sort of water damage; the papyrus is brittle and the ink is corroded. In other areas, the ink seems to have been almost erased leaving a slight depression on the otherwise pristine papyrus. We can observe a brown dust marring the whole surfaces, probably coming from the powdery part of the ink. Consolidation of the ink was deemed necessary to stop the powdery degradation of the ink and strengthen the corroded papyrus where needed.



Recently, successful consolidation of pages from Coptic codices was done using funori lightly sprayed on the whole surface (Darbre 2008, Jacobi 2023). However, in this case, any general humidification was to be avoided in order to preserve all the distortions and evidence of the past use. We therefore aimed for local consolidation of the writing alone.

To check safety of the treatment method we made tests on a Dutch Fe-Migration Mending Test (Neevel 2005). The funori, prepared at 1% was applied with a thin brush on the writing and let to dry. The tests show no magenta diffusion around the lines, proving the safety of the process.

## References

Florence Darbre, 2008, THE PAPYRUS CODEX TCHACOS- Its Authentication, Conservation, and Future, in *PapierRestaurierung*, vol 9, n°4, p 19-25.

Eliza Jacobi, Karin Sheper, Eve Menei, 2023, A Complete Coptic Codex: A material Study and Conservation Approach of a Relatively Unknown Bound Papyrus Manuscript, in *Julia Miller, Suave Mechanicals*, vol 8, p 154 - 195.

Johan G. Neevel and Birgit Reissland, 2005, Bathophenanthroline Indicator Paper, in *PapierRestaurierung*, vol 6, no. 4, P 28-35.

# P16. Where Lines Intersect. Reflections on a previous ink corrosion treatment of a 16th-century drawing from the Kupferstichkabinett of the Academy of Fine Arts Vienna

Elena Kersten and Sigrid Eyb-Green

Institute for Conservation - Restoration, Academy of Fine Arts Vienna, Austria  
✉ elena.kersten@onb.ac.at

The approach to treating ink corrosion damage has undergone significant changes since the 1970s. This work traces the development of treatment methods using a 16th century drawing in iron gall ink as an example and draws up a conservation concept that takes into account the current state of research. The artwork underwent conservation treatment approximately 50 years ago as part of a diploma thesis at the Academy of Fine Arts Vienna. Through analysis of the original work, insight is provided into the past of ink corrosion conservation, detailing how the damage was addressed when the exact causes were not yet fully understood. Due to the continued deterioration, further conservation of the object was necessary, involving the removal of backings and materials added in the 1970s. In order to swell the water-based adhesive without causing migration of harmful iron ions from the ink due to moisture, a new method was first developed based on a test series (Fig. 1.) and subsequently applied to the object. The method allows for localized treatment of ink corrosion and complexation of iron ions through the application of calcium phytate in the form of agar gel. Simultaneously, the moisture of the complexation solution swells the adhesive of the backings. A mineral clay poultice helps to largely prevent the formation of tide marks. Further testing is needed to make this promising method applicable for future use.



Figure 1. Preliminary tests of an agar gel poultice with calcium phytate on sample paper over a mineral clay substructure.

## References

1. Bazemore, Avery. Chelating Soluble Iron(II) from Iron Gall Ink. West Dean College, September 16, 2016.
2. Desbrière, Alimatou, Anne-Laurence Dupont, Thalia Bajon-Bouzid, and Isabelle Drieu la Rochelle. "Mineral Clays for Cleaning Tidelines on Paper-Based Artworks." *Restaurator (De Gruyter)* 44, no. 1 (2023): 53-76.
3. Klingler, Michael. Tinte und Tintenfraß - Bericht über die Restaurierung zweier Tintenzeichnungen [Ink and Ink Corrosion: Report on the Restoration of Two Ink Drawings]. Diploma thesis. Academy of Fine Arts, Vienna, 1973.

# P17. Rehabilitation project of the Historical Collection of the General Archive of Notaries (AHAGN) of Mexico City

Beatriz Aguilar Sánchez

Restorer of the Historical Archive of the General Notary Archive of Mexico City [beatrizag.sanchez@gmail.com](mailto:beatrizag.sanchez@gmail.com)

The Historical Collection of the General Archive of Notaries (AHAGN) of Mexico City is one of the oldest in the city and in Latin America, safeguarding a corpus of more than 33,000 volumes. Located since 2005 on the Ex-Temple of Corpus Christi, this collection is part of the General Archive of Notaries created in 1901 by provision of the Notarial Law for Mexico City, promulgated by President Porfirio Díaz (SIC MÉXICO, 2022). As part of the rehabilitation work carried out on the volumenes of the Antique and Reserved Collection of the notarial protocols that suffered damage as result of rainwater infiltration, coordinated actions of through rescue, recovery, cleaning, disinfection, stabilization, regulation and registration tasks contributed positively to the restoration of the intrinsic values contained in the damaged documentary assets.

This invaluable documents are made up of bindings dating from the 16th and 20th centuries, majority made of rag pulp paper, and some with mechanical and mixed pulp. In the case of damage related to ferrogallic inks and the support paper, partial losses were observed due to solubilization by excess humidity. The recovery percentage of each of the specimens was defined by the severity and extent of the damage observed. It is well known that the permanence of this type of ink depends largely on a correct and balanced formulation, since chemically their composition confers them a certain degree of insolubility in polar solutions (water). Therefore, it is believed that in part the instability of some inks is explained by the use of toning agents used in the formulation of the ink used, which gave it less stability.

Among the alterations identified in the volumes, many were linked to degradation processes of the paper, supported media (inks) or the materials that make up the bindings due to chemical and physical-chemical reactions that occurred throughout their development, others corresponded to degradation induced by biological agents (rodents, insects or microorganisms) originating at a time other than the rain accident.

As part of the processes carried out with the intention of resisting the stability of the paper support and achieving better legibility of the manuscripts, the washing of pages with a higher concentration of dirt and compounds from the hydrolysis and oxidation of the paper was carried out, drying fronts that prevented the visualization and reading of the manuscript. Likewise, sheets whose structural stability was compromised were laminated, reinforcements and grafts were added to restore strength to the paper support, as well as the stitching and the integration of the bindings.

## References

- Adcock, Edward P. (2000). *IFLA Principios para el cuidado y manejo de material de bibliotecas*. Chile.
- Ogden, Sheryln. (2000). *El manual de preservación de bibliotecas y archivos del Northeast Document Conservation Center*. DIBAM, Chile.
- Nishimura, Douglas W. (2011). *Understanding Preservation Metrics*. Instituto de Permanencia de la Imagen, Instituto de la Tecnología de Rochester, N.Y.
- Sanz Tejedor, Ascensión. (s.f.) *Tecnología de la celulosa. La industria papelera. Química Orgánica Industrial*.
- Secretaría de Economía, Dirección General de Normas. (2018) *Norma NMX-R-100- SCFI-2018 Acervos Documentales: Lineamientos para su Preservación*. SINEC-20181128175053228 ICS: 01.140.20.
- Sistema de Información Cultural SIC México. (2022). *Archivo General de Notarías de la Ciudad de México*.
- Velasco, T. (2004). *La técnica de manufactura de las encuadernaciones coloniales del Archivo General de la Nación*. Ciudad de México: Archivo General de la Nación.

# P18. Implementation of image analysis software in inspection workflows to assess the conservation of iron gall inks

Ania Rodríguez-Maciel<sup>a</sup> and E. Díaz-González<sup>b</sup>

<sup>a</sup>University La Laguna, Departament Fine Arts, Tenerife

<sup>b</sup>University La Laguna, Departament Fine Arts, and SADOA-SEGAI, Tenerife

✉arodrima@ull.edu.es

Iron gall inks, widely used in numerous historical manuscripts, face significant challenges regarding their stability and preservation. The corrosion associated with these inks can lead to substantial losses in the documentary supports, compromising both their integrity and legibility. An efficient inspection workflow is essential to assess their conservation status and make informed decisions to prevent further deterioration.

This research focused on the integration of open-source image analysis software into inspection workflows. This approach enables the precise study and quantification of areas affected by corrosion. It represents a novel methodology that offers a clear and reproducible framework, enhancing traditional visual inspection processes by complementing them with quantitative analyses.

The proposed workflow combines traditional visual inspection with advanced digital analysis. It consists of the following steps: visual inspection and classification of the folios according to the four conditions defined by the *Netherlands Institute for Cultural Heritage (ICN)* (Reißland & Hofenk de Graaff, 2001); photographic documentation using a digital camera of folios in condition 3 and 4, i.e., those exhibiting support losses and visible halos in inked areas; and analysis using open-source digital image analysis software. On one hand, the *Threshold* tool is used to segment the image, and *ROI Manager* is employed to select the areas of support loss and extract precise measurements of the lost area for each folio. On the other hand, the *Plot Profile* and *Profile Surface* tools are used to generate two- and three-dimensional graphs, providing information about the measurements and grayscale densities of the halos and the script (Ferreira & Rasband, 2012). The quantitative data obtained complements the visual evaluation.

The proposed workflow was validated on a collection of 16th-century historical manuscripts. Preliminary results demonstrate the effectiveness of this methodology as a complement to traditional methods. During the inspection, quantitative data were obtained on the degradation of documents classified in conditions 3 and 4 according to the ICN, including precise calculations of the area affected by support loss due to corrosion and the measurements of halos in inked areas.

The incorporation of digital image analysis software into the inspection protocol for iron gall inks facilitates the acquisition of quantitative data, provides a complementary approach to traditional visual inspections, offers a replicable resource for other similar institutions, and enables the monitoring of document deterioration over time. Therefore, this proposal, which integrates accessible digital tools and a replicable workflow, makes a significant contribution to the field of documentary heritage conservation.

## References

T. Ferreira, W. Rasband, 2012. *ImageJ User Guide Fiji 1.46*.

B. Reißland, J. Hofenk de Graaff, 2001. Condition rating for paper objects with iron-gall ink. *ICN-Information*, 1

# P19. “Corencre” Database dedicated to the iron gall ink drawings of the Louvre’s Museum

Ariane de La Chapelle

In charge of applied research in conservation, Louvre Museum , Prints and Drawings Department  
①Ariane.delachapelle@louvre.fr

Since 2017, we are developing a Database dedicated specifically to the Iron Gall Ink containing drawings from the Louvre’s collections at the Graphic Art Department.

This database appears as a logical suite to the participation of the author to the European Inkcors project. A specific vocabulary was needed, complementary to the support assessment, which was previously developed. This dedicated terms are declined in 11 peculiar specific description of the behaviour of the ink at the surface (as the presence of superficial micro cracking of the ink, of crystals, the reminiscent blackness (or not) of the ink under magnification etc. The all description is, intentionally limited at one page “fiche” (Fig.1)



Figure 1. Database description. Database illustrations

A focus of these description terms and their significance will be presented during the talk.

The previous support assessment (with the 1, 2, 3, 4, principal stages of corrosion degradation) is included as it has been consensually practiced and appreciated by numerous conservators. The nature of the migration (transversal and lateral) and his extent is mentioned, according to two different light (day light and U.V.) used during the observation. A choice of 6 photos is added as illustration ( Fig 2)

A selection of terms dedicated to the “tracé”, (used tool, thickness,..) the presence of secondary techniques , as the presence of highlights ,washes , are included as well as some of the more important observations on the actual mounting system. According to the results registered, a preconisation of a peculiar way to mount the drawing for its further conservation, minimising the mechanical risks, is indicated and will be presented.

# P20. Regulations versus practice and the Divine Name: ink analysis in medieval Torah scrolls

Rebecca Davenport<sup>a</sup> and Ira Rabin<sup>b</sup>

<sup>a</sup>Bundesanstalt für Materialforschung und -prüfung (BAM)

<sup>b</sup>Bundesanstalt für Materialforschung und -prüfung (BAM)

✉rebecca.davenport@bam.de

The medieval Rabbis had very strict rules for the construction of a Sefer Torah. The Divine Names should be written

- by a qualified scribe
- who is ritually pure
- in the presence of a *minyan* (10 adult Jewish men)
- in an appropriate frame of mind
- without being interrupted

However, when these scrolls were written it would have been impossible to verify any of this after the fact. While we do not currently have any way to determine how recently the scribes had bathed, or what they might have been thinking as they wrote, we can now know much more about the inscription of the Divine Name than these scribes ever would have guessed.

It is sometimes apparent from a visual inspection of the text that the Divine Name has been written in a second stage, from irregular letter kerning or a different ink colour. Using XRF, we have been able to discover more instances of a different ink used for the Name, and have shown that in some cases the secondary ink was also used to correct the main text, suggesting that the later writing was done by a master scribe who also proofread the entire scroll.

Using a Bruker M6 Jetstream, it has been possible to produce elemental “heat maps” of whole paragraphs or even large sections of a parchment sheet. Using such large samples of text, we can usefully compare the levels of copper and zinc used to write individual letters or words despite their relatively low concentration, which permits very fine differentiation of the inks used.

The techniques presented here would also be highly applicable to assessing ink degradation, as they are able to detect much smaller differences in ink composition than had previously been possible.

## References

G Nehring, O Bonnerot, N. Gordon, I Rabin, 2021, *COMSt Bulletin*, 7, 2-20

G Nehring, N Gordon, I Rabin, 2022, *J. Cult. Herit.*, 57, 142-148

# P21. Sustaining conservation through skills and craftsmanship: a case study on iron gall ink treatment and beyond in Mozart Manuscript K.35

Mito Matsumaru

ACR / Senior Conservator of Archives, Manuscripts and Books, Royal Bindery  
at Royal Collection Trust, Windsor Castle, Windsor, SL4 1NJ, UK  
✉mito.matsumaru@rct.uk

A great deal of research is available to help identify and refine new treatment techniques to mitigate iron-gall ink degradation on documents. Despite much progress in the field, there is still no “silver bullet”. Successful and sustainable treatments depend on a case-by-case balance between emerging techniques and traditional conservation skills. Sustainability in conservation extends beyond environmental and technical considerations to include the preservation of skills essential for safeguarding cultural heritage<sup>1</sup>.

This principle guided the conservation of Royal Collection Trust RCIN 1140995 ‘*Die Schuldigkeit des ersten Gebots K.35*’ (1767), a manuscript composed by Wolfgang Amadeus Mozart at the age of 11 years old<sup>2</sup>. Written in iron gall ink on handmade paper with a marbled paper covered binding, the manuscript had suffered from ink corrosion, leading to cracks and losses in the paper, worsened by historical water damage.

Ethical decision-making was central to the treatment of this manuscript. While a non-interventive approach was considered, targeted repairs were necessary to preserve the manuscript’s integrity and accessibility for future research and display. The author’s prior experience with similar treatments was invaluable in achieving a successful outcome on this high-profile item from the Royal Collection. This project underscores the value of inherited conservation skills, a concept rooted in Japanese conservation ethics, which emphasize the transmission of knowledge as part of heritage preservation<sup>3</sup>.

The project also exemplifies the multifaceted nature of sustainability in conservation. It emphasizes the importance of ethical decision-making, technical skills and intangible traditional craftsmanship to preserve tangible cultural heritage. In this instance, the creation by the Royal Bindery team of a conservation-grade drop-spine box decorated with traditional gold leaf finishing techniques<sup>4</sup>, allowing not only the provision of a stable storage environment for the manuscript, but increased gravitas to its presentation.

## References

1. English Heritage, 2023, *SUSTAINABLE CONSERVATION PRINCIPLES*, <https://www.english-heritage.org.uk/siteassets/home/about-us/our-priorities/sustainability/sustainable-conservation-strategy.pdf> (accessed 28/11/2024)
2. Royal Collection Trust <https://www.rct.uk/collection/1140995/die-schuldigkeit-des-ersten-gebots-the-duty-of-the-first-commandment> (accessed 28/11/2024)
3. The Japan Society for the Conservation of Cultural Property The Japan Society for the Conservation of Cultural Property (accessed 28/11/2024)
4. Heritage Craft Categories of risk - Heritage Crafts | (accessed 28/11/2024)

## P22. Iron gall ink problem on an 18<sup>th</sup> century French album kept in the Louvre Museum

Laurence Caylux<sup>a</sup>, A. de La Chapelle and Marthe Desroches

<sup>a</sup> Head paper conservator, Graphic art département, Louvre Museum

<sup>b</sup> Paper conservator, research engineer, Graphic art département, Louvre Museum

<sup>c</sup> Free lance paper conservator

①laurence.caylux@louvre.fr

The Graphic Arts department of the Louvre Museum keeps an album (Fig.1) with 43 drawings in iron gall ink with white highlight on blue paper by Jean-Baptiste Oudry, an 18<sup>th</sup> century French artist. The album is a calendar for the months of January and February illustrated by a scene from the life of the saint corresponding to each date of the month. On the page opposite each scene (on the back of the drawing on the previous page) an inscription in iron gall ink gives information on the life of the saint represented. The drawings as well as the inscriptions are surrounded by a broad framing line in iron gall ink which has strongly degraded the paper.



Figure 1. The album before restoration (left). Degrades areas near the binding (right).

Before the restoration, the pages could no longer be consulted because the paper, very brittle at the surrounded line, broke a little more with each handling. The most degraded area (tears and holes) (Fig.2) was the one near the binding where the tensions were the strongest when the pages were turned. The restoration was carried out at the restoration workshop of the Graphic Arts department from 2022 to 2023. We would like to share the reflection that we carried out for the choice of intervention and conservation of the album. We made numerous tests to select reinforcing papers and glues suitable for reinforcing the damages. Our constraint was also that our reinforcements had to be as transparent and discreet as possible since the pages can be viewed on both sides. Our choice fell on 4 g/m<sup>2</sup> Korean paper pre-glued with 5% sturgeon glue. The holes were filled with 20 g/m<sup>2</sup> Korean paper tinted with acrylic, also pre-glued. We will detail the characteristics of the materials used and their implementation. Despite the reinforcement of mechanical alterations, we chose not to reassemble the doubles pages in the binding which had been dismantled for the intervention. A suitable assembly system which we will detail has been developed to be able to consult the drawings without inducing tension during handling. A facsimile of the album will be made to preserve the memory of the object in 3 dimensions.

# P23. Conserving a crumbling collection: the case study of Curaçao

Claire Phan Tan Luu<sup>a</sup> and H. Schalkx<sup>b</sup>

<sup>a</sup>National Archives of the Netherlands, The Hague

<sup>b</sup>Hoogduin Papierrestauratoren, Delft

✉ [claire.phantanluu@nationaalarchief.nl](mailto:claire.phantanluu@nationaalarchief.nl)

The old archives of Curaçao, Bonaire and Aruba 1707-1828 (1.05.12.01, 1750 record numbers, 126,5 m1) contain documents from a large number of political, legal, military and religious institutions of these islands. They were transferred to the Netherlands in 1917. Most records consist of books or bundled pages made of rag paper and written with iron gall ink. The tropical conditions of their origin have resulted in serious ink corrosion as well as insect damage (Fig. 1 and 2). Some documents are extremely acidic and brittle, not to mention hard to read because of the brown discolouration of the paper (Fig. 3). Access to the documents is currently restricted due to their poor material condition. To ensure the accessibility of these archives, the National Archives decided to digitise them, following first line conservation. Normally a minimal intervention approach is taken, only performing conservation treatment in information areas and isolating parts that are too damaged. However, for this archive that would have meant excluding large parts of the information, and it was decided to perform more extensive treatment, varying from local repairs with pre-coated tissue to leaf-casting following a phytate treatment. Tests were done to determine the optimal treatment variables, such as leaf casting fibre content and method of resizing (Fig. 4). By categorising the documents according to the extent of their damage we were able to treat as many documents as possible, working our way from the least damage to the worst.



Figure 1. insect damage and ink corrosion



Figure 2. Ink corrosion

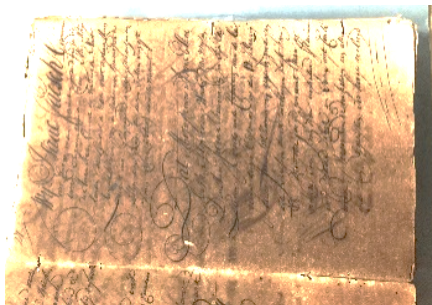


Figure 3. Brown discolouration leading to loss of readability.



Figure 4. Sizing test to increase legibility.

**IGI2025**

International  
**Iron Gall  
Ink Meeting  
2025**

*Towards a sustainable preservation*

